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(54) **Method and device for multiclass ATM connection admission control**

Verfahren und Anlage zur Zugangssteuerung für ATM-Verbindungen mit mehreren Klassen

Méthode et dispositif de contrôle d'accès pour des connexions ATM à plusieurs classes

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**Description**

BACKGROUND OF THE INVENTION

5 Technical Field of the Invention

**[0001]** The present invention relates to a method and device for connection admission control in ATM networks for determining whether calls may be connected by estimating cell loss ratios based on traffic parameters specified by users.

10 Background Art

**[0002]** In ATM networks, a number of service categories are available for responding to traffic having different properties (transmission speed, quality of service, etc.). Therefore, a connection admission control method which assumes the presence of a plurality of service categories is required.

**[0003]** As methods for connection admission control for determining whether calls may be connected based on traffic parameters specified by users, there are techniques wherein specific Quality of Service (QoS) requirements are fulfilled. These QoS requirements, for example, may be determined by cell loss ratios relating to the virtual paths (VPs) containing the calls.

20 **[0004]** As examples of connection admission control methods which perform processing in real-time, connection admission control methods which can be applied to a single service category (especially those assuming Variable Bit Rate) are commonly known. In these methods, traffic parameters (peak cell rate and sustainable cell rate) reported from users are taken as inputs, and connection admission processing is performed within a standard period of time without depending on the number of calls or the traffic conditions. These methods are applied for each VP, and are carried out in the connection admission control section 1' shown in Fig. 7 by means of the flow procedure shown in Fig. 8. Hereinbelow, this method will be explained in detail.

(1) In order to process call connections in real-time, the parameter  $N$  for the number of iterations is predetermined so that a single connection admission procedure is completed in a specific period of time.

30 (2) For each VP, an identifier  $i$  ( $i = 1, 2, \dots$ , number of already set up connections + 1) is provided for every user which has already been assigned a call or for which there has been a new call set-up request in the VP. A user  $i$  which issues a new call set-up request reports the peak cell rate  $r_i$  (1/sec), the sustainable cell rate  $a_i$  (1/sec) and the specified cell loss ratio value to the connection admission control section 1' (see Fig. 7).

35 (3) The connection admission control section 1' determines the maximum number of cell arrivals  $R_i$  and the average number of cell arrivals  $A_i$  in a time interval which is a constant  $\gamma$  times the time period required for the VP to transfer a single cell according to the following formulas (step Sf1) based on a peak cell rate and sustainable cell rate reported by the user.

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$$R_i = INT\left(\frac{\gamma \cdot L \cdot r_i}{C}\right)$$

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$$A_i = \frac{\gamma \cdot L \cdot a_i}{C}$$

50 Here,  $INT(x)$  is a function for the minimum integer greater than or equal to  $x$ .  $L$  represents the cell length (bit/cell).  $C$  represents the VP capacity (transmission speed in bit/sec).  $\gamma$  represents a constant (cells) which depends on the output buffer capacity  $K$  of the multiplexing device.

(4) The average  $C_1$ , variance  $C_2$  and third central moment  $C_3$  of the distribution of the number of cell arrivals for traffic in the case of assuming that a connection has been admitted for a new call set-up request are determined by the following formulas (step Sf2).

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$$C_1 = \sum_{i=1}^n A_i$$

$$C_2 = \sum_{i=1}^n A_i \cdot (R_i - A_i)$$

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$$C_3 = \sum_{i=1}^n A_i \cdot (R_i - A_i) \cdot (R_i - 2A_i)$$

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Here,  $n$  denotes the number of connections both already set-up and required to be set-up.

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(5) If for a pre-determined parameter  $N$  denoting the number of iterations, the third central moment  $C_3$  satisfies the following inequality:

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$$C_3 < \frac{-C_2 \cdot X(N) \cdot (\gamma - C_1) + \sqrt{\{C_2 \cdot X(N) \cdot (\gamma - C_1)\}^2 + 4 \cdot X(N) \cdot (1 - X(N)) \cdot C_2^3 \cdot (N + 1)}}{2 \cdot X(N) \cdot (N + 1)}$$

25

wherein

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$$X(N) = 1 - \frac{1 + \sqrt{3 - 2/N}}{N - 1}$$

then the third central moment  $C_3$  may be redefined, as a corrected value, to the following (step Sf3):

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$$C_3 = \frac{-C_2 \cdot X(N) \cdot (\gamma - C_1) + \sqrt{\{C_2 \cdot X(N) \cdot (\gamma - C_1)\}^2 + 4 \cdot X(N) \cdot (1 - X(N)) \cdot C_2^3 \cdot (N + 1)}}{2 \cdot X(N) \cdot (N + 1)}$$

40

(6)  $R$  and  $A$  are determined by the following formulas (step Sf4).

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$$R = \frac{C_3}{C_2}$$

$$A = \frac{C_2^2}{C_3}$$

50

(7) The estimated cell loss ratio value  $*B$  is determined by the following equation (step Sf5).

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$$*B = \frac{1}{C_1} \sum_{k=0}^{N-1} \max(0, k \cdot R + \delta A - \gamma) \cdot (*p(kR))$$

In this case, when  $k = 0, 1, 2, \dots$ , then

5

$$*p(kR) = \exp\left(-\frac{A}{R}\right) \cdot \left\{ \frac{(A/R)^k}{k!} \right\}$$

otherwise,

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$$*p(kR) = 0$$

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The amount of time required for this calculation does not depend on the number of types of calls or the number of calls, and is completely determined by the pre-determined parameter  $N$  which is the number of iterations. According to this calculation, a sufficiently precise value for the cell loss ratio estimate  $*B$  can be obtained.

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(8) The connection admission control section 1' compares the above-mentioned cell loss ratio estimate  $*B$  with the specified cell loss ratio reported for the "relevant call" and "all calls already set-up in the VP in which the call is to be set-up". Then, as a result of the comparison, when the above-mentioned cell loss estimate  $*B$  is less than any of the specified cell loss values, the call for which connection has been requested is determined to be connectable (step Sf6). If not, the call connection is determined to be impermissible. Then, the results are reported to the users (see Fig. 7).

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(9) When connection is determined to be possible in all of the VPs through which the call passes, then the connection of the call is permitted.

**[0005]** According to the above procedure, it is possible to perform connection admission control of a call within a pre-determined time period.

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**[0006]** The above-mentioned conventional art does not perform convolution calculations which depend on the number of connections and the number of types of calls. For this reason, the calculation time is determined solely by the pre-determined parameter  $N$  denoting the number of iterations and it is possible to determine the cell loss ratio estimates  $*B$  based on calculated amounts which do not depend on the VC numbers or VC classification numbers, so as to achieve real-time connection admission control which satisfies the communication QoS requirements determined by the cell loss ratios.

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**[0007]** However, in actual practice, connection admission processing must be capable of handling a plurality of service categories, and connection admission control methods responsive to only a single class (such as only VBR) are inadequate. In ATM networks, traffic of different service categories shares the transmission paths, so that the behavior of traffic belonging to one service category may have an adverse influence on traffic belonging to another service category. Hence, it is not suitable to determine whether or not to allow a call to be connected independently by the service category. Therefore, there has been a demand for a multi-class connection admission control method which determines whether or not to allow a call to be connected while simultaneously predicting the influence on the QoS of a plurality of service categories.

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**[0008]** A prior art document, the article of Hiroshi Saito entitled "Hybrid Connection admission Control in ATM networks" (Discovering a new world of Communications, Chicago, juin 14-18, 1992, vol. 2, pages 699-703, Institute of Electrical and Electronics Engineers) proposes a new connection admission control (CAC) called a hybrid CAC. The hybrid CAC provides two cell loss rate classes, and requires the declaration of each VC's peak cell rate as a traffic parameter. The admission of a low-priority VC is decided based on the measured number of cells arriving from connected VCs and the specified peak rates. The bandwidth assigned to a high-priority VC is the specified peak, but the bandwidth that is not actually used by the high-priority VC can be used by low-priority VCs. Therefore, the hybrid CAC attains high utilization and high quality for high-priority VCs with only the peak cell rate needing to be specified.

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**[0009]** An other prior art document, the article of Hluchyj M G; Bhargawa A. entitled "Queuing Disciplines for integrated fast packet networks" (Discovering a new world of communications, Chicago, 14 June 1992-18 June 1992, vol. 4, pages 990 to 996) considers queuing discipline used to multiplex packets onto an intermodal link which is an important element in the overall bandwidth management of an integrated fast packet network. The characteristics of and quality of service (QOS) required by different traffic classes (constant bit rate, voice, data, image and video) are reviewed and used as the basis for comparing alternative queuing disciplines. A hybrid weighted round-robin (WRR) and head-of-line priority (HOLP) discipline is shown to provide appropriate allocation of the intermodal link bandwidth among different traffic classes, while allowing delay differentiation within a traffic class.

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SUMMARY OF THE INVENTION

**[0010]** In order to resolve the above-mentioned problems, the present invention has the object of offering a method and device for connection admission control capable of handling a plurality of service categories simultaneously without sacrificing the real-time processing of conventional connection admission control methods.

**[0011]** The present invention receives a connection request for a call belonging to one of a plurality of service categories with assigned priority levels; classifies the received connection request based on a service category requested by the connection request; evaluates, for each service category, the change in quality of service between the service category requested by the connection request and the service categories which lower priority levels than that service category when assuming that the received connection request has been admitted; based on the results of the evaluation, determines whether or not to allow the connection of the received connection request; and for the calls of connection requests which have been determined to be admissible, permits the cells of those calls to be stored in buffers which are respectively provided for each service category and which perform cell transmissions on the basis of the rule that cells of lower priority levels are not transmitted as long as all of the cells of service categories of higher priority levels have not been transmitted.

**[0012]** According to the present invention, the admissibility of connection of a call belonging to a service category is determined by considering not only the QoS of that service category but also the influence on the QoS of other service categories. Additionally, the judgment process does not depend on the number of calls for which connection is requested, and is completed in a standard amount of time. As a result, connection admission control of calls which can handle a plurality of service categories and can be processed in real-time is possible.

BRIEF EXPLANATION OF THE DRAWINGS

**[0013]**

Fig. 1 is a block diagram showing an example of the structure of an output buffer provided in an ATM exchanger according to an embodiment of the present invention.

Fig. 2 is a block diagram showing an example of the structure of a connection admission control section 1 according to the same embodiment.

Fig. 3 is a flow chart showing an example of a process performed by a CBR connection admission processing section 1b.

Fig. 4 is a flow chart showing an example of a process performed by a RtVBR connection admission processing section 1c.

Fig. 5 is a flow chart showing an example of a process performed by a NrtVBR connection admission processing section 1d.

Fig. 6 is a flow chart showing an example of a process performed by a Best Effort Classes connection admission processing section 1e.

Fig. 7 is a block diagram showing an example of an ATM network using a conventional connection admission control section 1'.

Fig. 8 is a flow chart showing an example of a process performed by a conventional connection admission control section 1'.

PREFERRED EMBODIMENTS OF THE INVENTION

**[0014]** Hereinbelow, a first embodiment of the present invention shall be explained with reference to the drawings.

§1. Outline

**[0015]** In the present embodiment, CBR, Real-time VBR (RtVBR), Non-real-time VBR (NrtVBR), Best Effort Class (ABR, UBR) are assumed as service categories. Of course, the types of service categories applicable to the present invention are not restricted to those in the present embodiment, and the expansion to other variations is easily done. Additionally, the traffic parameters of the CBR and Best Effort Class categories are only the peak cell rate. On the other hand, the traffic parameters in the RtVBR and NrtVBR categories are the peak cell rate and the sustainable cell rate.

**[0016]** The cells inputted from the call sources belonging to these service categories are inputted into buffers which are provided for each service category in the ATM exchanger (see Fig. 1). The structure of the buffers is not restricted to that of Fig. 1, and may be designed according to the types of service categories. Each buffer is assigned a priority ranking for cell transfer. The priority ranking may be, for example, in the order of higher priority, CBR, RtVBR, NrtVBR, Best Effort Class. Cells which are present in a buffer are transferred as long as there are no cells present in buffers

having higher priority than that buffer.

**[0017]** As a result, traffic belonging to some service category will not affect the QoS evaluations for traffic belonging to service categories of higher priority. Conversely, high priority traffic affects lower priority traffic. Hence, connection admission processing of calls for traffic of high priority must be performed in consideration of the influence on the QoS of lower priority traffic. Additionally, in order to predict whether or not there will be an influence, QoS evaluation techniques are required for each service category.

**[0018]** The present invention performs connection admission control of calls in a plurality of service categories in real-time. The present invention is based on the following art.

1. In the ATM exchanger, a buffer is provided for each service category (Fig. 1). Then, the priority level for cell transfer is assigned between the buffers. Cell transfer in a buffer belonging to a service category is performed only when no cells are present in any of the buffers having higher priority than that buffer.

As a result, the behavior of each service category can be prevented from influencing the QoS of service categories which are of higher priority than that service category. Consequently, QoS evaluation processing of service categories is made possible simply by considering the influence on the QoS of service categories of priority levels lower than those service categories.

2. Using conventional connection admission control methods (connection admission control methods responsive to a single class), QoS evaluation processing is performed for each service category. As a result, it is possible to perform QoS evaluation processing by the service category in real-time.

Specifically, this technique involves using a conventional connection admission control method to make real-time evaluations of the cell loss ratios for traffic wherein calls of a plurality of service categories are multiplexed, after which the cell loss ratio is evaluated for a low priority service category while assuming that all of the lost cells belong to the low priority service category.

3. When a call assignment request belonging to some service category is received, the QoS of that service category and service categories of lower priority levels are evaluated according to the service category using the QoS evaluation technique according to the service category as described in the above paragraph 2, and the assignment request is admitted only when all of the QoS evaluation values fulfill the specified values.

**[0019]** As a result, it is possible to perform connection admission control of a plurality of service categories while considering the influence on the QoS of each VP for connections which have already been assigned.

## §2. Embodiments

**[0020]** Hereinbelow, at ATM connection admission control method according to an embodiment of the present invention shall be explained.

**[0021]** In the present embodiment, a connection admission section 1 is used instead of the conventional connection admission section 1' in an ATM network such as shown in Fig. 7. Fig. 2 is a block diagram showing an example of the structure of a connection admission control section 1. The connection admission control section 1 adds the control function of controlling the buffers as shown in Fig. 1 to the conventional connection admission section 1'. The present ATM connection admission control method is applied for each VP by means of the connection admission control section 1.

**[0022]** With this type of structure, the connection admission control method due to the present invention is performed by the following procedure.

1. In order to process the connection of calls in real-time, the number of iterations  $N$  which are allowable for cell loss ratio evaluation processing in the VP is determined beforehand.

2. For each VP, all of the users for which connection to the VP has already been assigned and users for which new call connection requests have been issued are given an identifier  $i$  ( $i = 1, 2, \dots$ , number of already set-up connections + 1).

When requesting the assignment of a call, a user  $i$  which has issued a new call connection request reports the desired category (CBR, RtVBR, NrtVBR, Best Effort Classes), the peak cell rate  $r_i$  (1/sec), the sustained cell rate  $a_i$  (1/sec; but only when the desired category is RtVBR or NrtVBR) and the specified cell loss ratio value to the connection admission section 1.

3. A service category check section 1a (see Fig. 2) classifies the calls for which connection requests have issued based on the service categories (CBR, RtVBR, NrtVBR, Best Effort Classes) reported by the user, and turns the call over to the corresponding connection admission processing section.

4. Each connection admission processing section 1b-1e performs the following connection procedures and issues notification of whether or not connection has been allowed.

5. When connection is determined to be allowable for all VPs in which the call is contained, the connection of the call is permitted.

[0023] Next, the procedure of the above paragraph 4 (connection procedures for connection admission processing sections 1b-1e) shall be explained separately.

(1) Procedure of CBR connection admission processing section 1b:

[0024] The CBR connection admission section 1b performs the following procedure (see Fig. 3).

1. (sum of peak cell rates of connected CBR calls) + (peak cell rate of CBR call to be judged for connectability) is calculated (step Sb1).
2. The band resulting by subtracting the above-mentioned band (i.e. the results of step Sb1) from the entire VP band is calculated and the result is defined to be the remainder band Z (step Sb2).
3. If the remainder band Z is positive, then the procedure advances to step Sb4; if not, then a connection denial notification is issued and the procedure is terminated (step Sb3).
4. The cell loss ratio  $B_{nrt}$  for only NrtVBR is estimated under the assumption that only the connected RtVBR calls and NrtVBR calls are contained in the remainder band Z (step Sb4). The procedure is as follows:

- The following amounts are calculated for all connected RtVBR calls and NrtVBR calls based on the peak cell rate and sustained cell rate of these calls.

$$R_i = INT\left(\frac{\gamma \cdot L \cdot r_i}{C}\right)$$

$$A_i = \frac{\gamma \cdot Y \cdot a_i}{C}$$

Here,  $INT(x)$  is a function for the minimum integer greater than or equal to  $x$ .  $L$  represents the cell length (bit/cell).  $C$  represents the VP capacity (transmission speed in bit/sec).  $\gamma$  represents a constant (cells) which depends on the output buffer capacity  $K$  of the multiplexing device.

- Next, the following value  $\Gamma$  is calculated.

$$\Gamma = \frac{\gamma \cdot Z}{C}$$

- The cell loss ratio estimate  $*B$  is calculated by applying  $R_i$ ,  $A_i$  and  $\Gamma$  to a conventional connection admission method (connection admission method responsive to a single class) according to the following formula (see steps Sf2-Sf5 in Fig. 8):

$$*B = \frac{1}{C_1} \sum_{k=0}^{N-1} \max(0, k \cdot R + \delta A - \Gamma) \cdot (*p(kR))$$

- The cell loss estimate  $*B$  is the cell loss ratio for the mixed traffic of RtVBR and NrtVBR. Therefore, in order to estimate the cell loss ratio  $B_{nrt}$  of only NrtVBR, then it is assumed that cell loss arises in all NrtVBR cells, and the following calculation is performed:

$$B_{nrt} = (*B) \cdot \frac{\sum_{i \in RtVBR} a_i + \sum_{i \in NrtVBR} a_i}{\sum_{i \in NrtVBR} a_i}$$

EP 0 814 632 B1

5. If the above-mentioned cell loss ratio  $B_{nrt}$  for only NrtVBR is less than or equal to the predetermined value, the procedure advances to step Sb6; if not, a connection denial notification is issued and the procedure is terminated (step Sb5).

6. Assuming that only the connected RtvVBR calls are contained in the above-mentioned remainder band Z, the cell loss ratio  $B_{rt}$  of only RtvVBR is estimated (step Sb6). The procedure is as follows.

- The following amounts are calculated for all connected RtvVBR calls based on the peak cell rate and sustained cell rate of these calls.

$$R_i = INT\left(\frac{\gamma \cdot L \cdot r_i}{C}\right)$$

$$A_i = \frac{\gamma \cdot L \cdot a_i}{C}$$

Here, INT(x) is a function for the minimum integer greater than or equal to x. L represents the cell length (bit/cell). C represents the VP capacity (transmission speed in bit/sec).  $\gamma$  represents a constant (cells) which depends on the output buffer capacity K of the multiplexing device.

- Next, the following value  $\Gamma$  is calculated.

$$\Gamma = \frac{\gamma \cdot Z}{C}$$

- The cell loss ratio estimate  $*B$  is calculated by applying  $R_i$ ,  $A_i$  and  $\Gamma$  to a conventional connection admission method (connection admission method responsive to a single class) according to the following formula (see steps Sf2-Sf5 in Fig. 8):

$$*B = \frac{1}{C_1} \sum_{k=0}^{N-1} \max(0, k \cdot R + \delta A - \Gamma) \cdot (*p(kR))$$

- The above-mentioned cell loss ratio estimate  $*B$  is taken to be the cell loss ratio  $B_{rt}$  for only RtvVBR.

$$B_{rt} = *B$$

7. If the above-mentioned cell loss ratio  $B_{rt}$  for only RtvVBR is less than or equal to the predetermined value, then a connection admission notification is issued for the CBR call for which connection was requested. If not, a connection denial notification is issued (step Sb7).

8. The connection of the call is permitted when connection is determined to be allowable in all of the VPs through which the call passes.

(2) Procedure of RtvVBR connection admission processing section 1c:

**[0025]** The RtvVBR connection admission processing section 1c performs the following procedure (see Fig. 4).

1. The band resulting by subtracting the band corresponding to the sum of peak cell rates of connected CBR calls from the entire VP band is calculated and the result is defined to be the remainder band Z (step Sc1).

2. The cell loss ratio  $B_{nrt}$  for only NrtVBR is estimated under the assumption that only the connected RtvVBR calls, NrtVBR calls and RtvVBR for which connection requests have issued are contained in the remainder band Z (step Sc2). The procedure is as follows:

EP 0 814 632 B1

- The following amounts are calculated for all connected RtVBR calls, NrtVBR calls and RtVBR calls for which connection requests have issued based on the peak cell rate and sustained cell rate of these calls.

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$$R_i = INT\left(\frac{\gamma \cdot L \cdot r_i}{C}\right)$$

10

$$A_1 = \frac{\gamma \cdot L \cdot a_1}{C}$$

15

Here, INT(x) is a function for the minimum integer greater than or equal to x. L represents the cell length (bit/cell). C represents the VP capacity (transmission speed in bit/sec).  $\gamma$  represents a constant (cells) which depends on the output buffer capacity K of the multiplexing device.

- Next, the following value  $\Gamma$  is calculated.

20

$$\Gamma = \frac{\gamma \cdot Z}{C}$$

- The cell loss ratio estimate \*B is calculated by applying  $R_i$ ,  $A_i$  and  $\Gamma$  to a conventional connection admission method (connection admission method responsive to a single class) according to the following formula (see steps Sf2-Sf5 in Fig. 8):

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$$*B = \frac{1}{C_1} \sum_{k=0}^{N-1} \max(0, k \cdot R + \delta A - \Gamma) \cdot (*p(kR))$$

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- The cell loss estimate \*B is the cell loss ratio for the mixed traffic of RtVBR and NrtVBR. Therefore, in order to estimate the cell loss ratio  $B_{nrt}$  of only NrtVBR, then it is assumed that cell loss arises in all NrtVBR cells, and the following calculation is performed:

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$$B_{nrt} = (*B) \cdot \frac{\sum_{i \in RtVBR} a_i + a' + \sum_{i \in NrtVBR} a_i}{\sum_{i \in NrtVBR} a_i}$$

40

Here, a' denotes the sustained cell rate for RtVBR calls for which connection requests have been issued.

3. If the above-mentioned cell loss ratio  $B_{nrt}$  for only NrtVBR is less than or equal to the predetermined value, the procedure advances to step Sc4; if not, a connection denial notification is issued and the procedure is terminated (step Sc3).

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4. Assuming that only the connected RtVBR calls and the RtVBR calls for which connection requests have issued are contained in the above-mentioned remainder band Z, the cell loss ratio  $B_{rt}$  of only RtVBR is estimated (step Sc4). The procedure is as follows.

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- The following amounts are calculated for all connected RtVBR calls and Rt VBR calls for which connection requests have issued based on the peak cell rate and sustained cell rate of these calls.

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$$R_i = INT\left(\frac{\gamma \cdot L \cdot r_i}{C}\right)$$

EP 0 814 632 B1

$$A_i = \frac{\gamma \cdot L \cdot a_i}{C}$$

5 Here, INT(x) is a function for the minimum integer greater than or equal to x. L represents the cell length (bit/cell). C represents the VP capacity (transmission speed in bit/sec).  $\gamma$  represents a constant (cells) which depends on the output buffer capacity K of the multiplexing device.

- Next, the following value  $\Gamma$  is calculated.

$$10 \quad \Gamma = \frac{\gamma \cdot Z}{C}$$

- The cell loss ratio estimate \*B is calculated by applying  $R_i$ ,  $A_i$  and  $\Gamma$  to a conventional connection admission method (connection admission method responsive to a single class) according to the following formula (see steps Sf2-Sf5 in Fig. 8):

$$20 \quad *B = \frac{1}{C_1} \sum_{k=0}^{N-1} \max(0, k \cdot R + \delta A - \Gamma) \cdot (*p(kR))$$

- The above-mentioned cell loss ratio estimate \*B is taken to be the cell loss ratio  $B_{rt}$  for only RtVBR.

$$25 \quad B_{rt} = *B$$

5. If the above-mentioned cell loss ratio  $B_{rt}$  for only RtVBR is less than or equal to the predetermined value, then a connection admission notification is issued for the RtVBR call for which connection was requested. If not, a connection denial notification is issued (step Sc5).

6. The connection of the call is permitted when connection is determined to be allowable in all of the VPs through which the call passes.

(3) Procedure of NrtVBR connection admission processing section 1d:

35 **[0026]** The RtVBR connection admission processing section 1d performs the following procedure (see Fig. 5).

1. The band resulting by subtracting the band corresponding to the sum of peak cell rates of connected CBR calls from the entire VP band is calculated and the result is defined to be the remainder band Z (step Sd1).

40 2. The cell loss ratio  $B_{nrt}$  for only NrtVBR is estimated under the assumption that only the connected RtVBR calls, NrtVBR calls and NrtVBR for which connection requests have issued are contained in the remainder band Z (step Sd2). The procedure is as follows:

- The following amounts are calculated for all connected RtVBR calls, NrtVBR calls and NrtVBR calls for which connection requests have issued based on the peak cell rate and sustained cell rate of these calls.

$$50 \quad R_i = INT\left(\frac{\gamma \cdot L \cdot r_i}{C}\right)$$

$$55 \quad A_i = \frac{\gamma \cdot L \cdot a_i}{C}$$

Here, INT(x) is a function for the minimum integer greater than or equal to x. L represents the cell length (bit/cell). C represents the VP capacity (transmission speed in bit/sec).  $\gamma$  represents a constant (cells) which de-

depends on the output buffer capacity  $K$  of the multiplexing device.

- Next, the following value  $\Gamma$  is calculated.

$$\Gamma = \frac{\gamma \cdot Z}{C}$$

- The cell loss ratio estimate  $*B$  is calculated by applying  $R_i$ ,  $A_i$  and  $\Gamma$  to a conventional connection admission method (connection admission method responsive to a single class) according to the following formula (see steps Sf2-Sf5 in Fig. 8):

$$*B = \frac{1}{C_1} \sum_{k=0}^{N-1} \max(0, k \cdot R + \delta A - \Gamma) \cdot (*p(kR))$$

- The cell loss estimate  $*B$  is the cell loss ratio for the mixed traffic of RtVBR and NrtVBR. Therefore, in order to estimate the cell loss ratio  $B_{nrt}$  of only NrtVBR, the following calculation is performed:

$$B_{nrt} = (*B) \cdot \frac{\sum_{i \in \text{RtVBR}} a_i + a' + \sum_{i \in \text{NrtVBR}} a_i}{\sum_{i \in \text{NrtVBR}} a_i}$$

Here,  $a'$  denotes the sustained cell rate for NrtVBR calls for which connection requests have been issued.

3. If the above-mentioned cell loss ratio  $B_{nrt}$  for only NrtVBR is less than or equal to the predetermined value, a connection admission notification is issued. If not, a connection denial notification is issued (step Sd3).

4. The connection of the call is permitted when connection is determined to be allowable in all of the VPs through which the call passes.

(3) Procedure of Best Effort Classes connection admission processing section 1e:

**[0027]** The Best Effort Classes connection admission processing section 1e performs the following procedure (see Fig. 6).

1. If the peak cell rate of a Best Effort Classes call for which connection has been requested is less than or equal to the capacity of all VPs, then a connection admission notification is issued for the Best Effort Classes call. If not, a connection denial notification is issued (step Se1).

2. The connection of the call is permitted when connection is determined to be allowable in all of the VPs through which the call passes.

**[0028]** According to the above procedures, connection admission control can be performed with respect to a plurality of service categories without having any detrimental influence on the QoS of other service categories. Furthermore, the processing for connection admission control is completed within a predetermined amount of time.

**[0029]** While an embodiment of the present invention has been explained above with reference to the drawings, the detailed structure is not necessarily restricted to this embodiment.

**[0030]** For example, in the above embodiment, the cell loss ratio estimate  $*B$  was calculated by the following equation.

$$*B = \frac{1}{C_1} \sum_{k=0}^{N-1} \max(0, k \cdot R + \delta A - \Gamma) \cdot (*p(kR))$$

**[0031]** However, the formula for calculating the cell loss ratio estimate  $*B$  is not necessarily restricted to the above equation, and as long as the calculation formula is such as to be capable of estimating the cell loss ratio after connection with respect to a single service category, application is generally possible by combining with the cell transmission method proposed by the present invention, that is, a cell transmission method wherein a buffer is provided for each

service category, and the cells of lower priority service categories are not transmitted while cells remain in higher priority service categories. For example, the cell loss ratio estimate \*B may also be determined by the following formula.

5

$$*B = \frac{\sum_k \max(0, k - \Gamma) \cdot \{p_1 \# p_2 \# \dots \# p_n\}(k)}{\sum_k k \cdot \{p_1 \# p_2 \# \dots \# p_n\}(k)}$$

[0032] Here, the symbol "#" represents a convolution. Additionally,  $p_i(k)$  is the value indicated below.

10

$$p_i(k) = \begin{cases} 1 - A/R_i & k = 0 \\ A/R_i & k = R_i \\ 0 & \text{otherwise} \end{cases}$$

15

**Claims**

20

1. A multi-class ATM connection admission method comprising the steps of:

receiving a connection request for a call belonging to one of a plurality of service categories with assigned priority levels;

25

classifying the received connection request based on a service category requested by the connection request; evaluating a quality of service of said service category requested by the connection request and evaluating a quality of service of each other service category, when assuming that the received connection request has been admitted, the evaluating step further comprising the substeps of:

30

estimating a cell loss ratio for traffic wherein calls of the service category for which the connection request has been received and calls of service categories of lower priority levels are multiplexed, and estimating a cell loss ratio of said service categories of lower priority levels when assuming that all of the lost cells based on the cell loss ratio of said traffic belong to said service categories of lower priority levels;

35

determining whether or not to admit the received connection request based on results of said evaluations; and permitting cells of said call to be stored in a buffer when the connection request for said call has been determined to be admissible.

40

2. A multi-class ATM connection admission method in accordance with claim 1, wherein, in the step of permitting cells of said call to be stored in an appropriate buffer when the connection request for said call has been determined to be admissible, a buffer is provided for each service category and said priority levels are assigned for each buffer; and which further comprises the step of:

45

transferring the cells stored in each buffer over a transmission path only when there are no cells present in any buffers having higher priority levels.

3. A multi-class ATM connection admission method in accordance with claim 1, which further comprises the step of:

50

determining the received connection request to be admissible when the cell loss ratio of the service category requested by the received connection request is less than or equal to a specified cell loss ratio reported on the service category, and the cell loss ratio estimated for each of said service categories of lower priority levels is less than or equal to a specified cell loss ratio respectively reported on each service category.

55

4. A multi-class ATM connection admission method in accordance with claim 1, which comprises the steps of:

determining the received connection request to be admissible when the cell loss ratio of the service category requested by the received connection request is less than or equal to a specified cell loss ratio reported on the service category, and the cell loss ratio estimated for each of said service categories of lower priority levels

is less than or equal to a specified cell loss ratio respectively reported on each service category;  
permitting cells of said call to be stored in an appropriate buffer when the connection request for said call has  
been determined to be admissible, wherein a buffer is provided for each service category and said priority  
levels are assigned for each buffer; and  
5 transferring the cells stored in each buffer over a transmission path only when there are no cells present in  
any buffers having higher priority levels.

5. A multi-class ATM connection admission device comprising:

10 receiving means for receiving a connection request for a call belonging to one of a plurality of service categories  
with assigned priority levels;  
classifying means for classifying the received connection request based on a service category requested by  
the connection request;  
15 evaluating means for evaluating a quality of service of said service category requested by the connection  
request and evaluating a quality of service of each other service category, when assuming that the received  
connection request has been admitted, the evaluating means further comprising:

20 estimating means for estimating a cell loss ratio for traffic wherein calls of the service category for which  
the connection request has been received and calls of service categories of lower priority levels are mul-  
tiplexed, and

estimating means for estimating a cell loss ratio of said service categories of lower priority levels when  
assuming that all of the lost cells based on the cell loss ratio of said traffic belong to said service categories  
of lower priority levels;

25 determining means for determining whether or not to admit the received connection request based on results  
of said evaluations; and  
permission means for permitting cells of said call to be stored in a buffer when the connection request for said  
call has been determined to be admissible.

30 6. A multi-class ATM connection admission device in accordance with claim 5, wherein, in the permission means for  
permitting cells of said call to be stored in an appropriate buffer when the connection request for said call has been  
determined to be admissible, a buffer is provided for each service category and said priority levels are assigned  
for each buffer; and which further comprises:

35 transfer means for transferring the cells stored in each buffer over a transmission path only when there are  
no cells present in any buffers having higher priority levels.

7. A multi-class ATM connection admission device in accordance with claim 5, which comprises:

40 determining means for determining that the received connection request is admissible when the cell loss ratio  
of the service category requested by the received connection request is less than or equal to a specified cell  
loss ratio reported on the service category, and the cell loss ratio estimated for each of said service categories  
of lower priority levels is less than or equal to a specified cell loss ratio respectively reported on each service  
category.

45 8. A multi-class ATM connection admission device in accordance with claim 5, which comprises:

determining means for determining that the received connections request is admissible when the cell loss ratio  
of the service category requested by the received connection request is less than or equal to a specified cell  
50 loss ratio reported on the service category, and the cell loss ratio estimated for each of said service categories  
of lower priority levels is less than or equal to a specified cell loss ratio respectively reported on each service  
category;

55 permission means for permitting cells of said call to be stored in an appropriate buffer when the connection  
request for said call has been determined to be admissible, wherein a buffer is provided for each service  
category and said priority levels are assigned for each buffer; and

transfer means for transferring the cells stored in each buffer over a transmission path only when there are  
no cells present in any buffers having higher priority levels.

**Patentansprüche**

1. Mehrklassen-ATM-Verbindungszulassungsverfahren, das die folgenden Schritte umfasst:

5           Empfangen einer Verbindungsanforderung für einen Anruf, der zu einer von mehreren Dienstkategorien mit zugewiesenen Prioritätsniveaus gehört;  
 Klassifizieren der empfangenen Verbindungsanforderung anhand einer durch die Verbindungsanforderung angeforderten Dienstkategorie;  
 10          Bewerten einer Dienstqualität der durch die Verbindungsanforderung angeforderten Dienstkategorie und Bewerten einer Dienstqualität jeder anderen Dienstkategorie, unter der Annahme, dass die empfangene Verbindungsanforderung zugelassen worden ist, wobei der Bewertungsschritt die folgenden Unterschritte umfasst:

            Schätzen eines Zellenverlustverhältnisses für den Verkehr, in dem Anrufe der Dienstkategorie, für die die Verbindungsanforderung empfangen worden ist, und Anrufe von Dienstkategorien mit niedrigeren Prioritätsniveaus multiplexiert sind, und  
 15           Schätzen eines Zellenverlustverhältnisses der Dienstkategorien mit niedrigeren Prioritätsniveaus, wenn angenommen wird, dass alle auf der Grundlage des Zellenverlustverhältnisses des Verkehrs als verloren geltenden Zellen zu den Dienstkategorien mit niedrigeren Prioritätsniveaus gehören;

20          Feststellen, ob die empfangene Verbindungsanforderung zugelassen werden soll oder nicht, anhand von Ergebnissen der Bewertungen; und  
 Gewähren, dass Zellen des Anrufs in einem Puffer gespeichert werden, wenn für die Verbindungsanforderung für den Anruf festgestellt worden ist, dass sie zulässig ist.

- 25    **2.** Mehrklassen-ATM-Verbindungszulassungsverfahren nach Anspruch 1, bei dem im Schritt des Gewährens, dass Zellen des Anrufs in einem geeigneten Puffer gespeichert werden, wenn für die Verbindungsanforderung für den Anruf festgestellt worden ist, dass sie zulässig ist, ein Puffer für jede Dienstkategorie vorgesehen wird und die Prioritätsniveaus jedem Puffer zugewiesen werden; und das ferner den folgenden Schritt umfasst:

30           Übertragen der in jedem Puffer gespeicherten Zellen über einen Übertragungsweg nur dann, wenn in irgendwelchen Puffern mit höheren Prioritätsniveaus keine Zellen vorhanden sind.

- 3.** Mehrklassen-ATM-Verbindungszulassungsverfahren nach Anspruch 1, das ferner den folgenden Schritt umfasst:

35           Feststellen, dass die empfangene Verbindungsanforderung zulässig ist, wenn das Zellenverlustverhältnis der durch die empfangene Verbindungsanforderung angeforderten Dienstkategorie kleiner oder gleich einem bestimmten Zellenverlustverhältnis ist, das bezüglich der Dienstkategorie gemeldet wird, und wenn das Zellenverlustverhältnis, das für jede der Dienstkategorien mit niedrigeren Prioritätsniveaus geschätzt wird, kleiner oder gleich einem bestimmten Zellenverlustverhältnis ist, das entsprechend bezüglich jeder Dienstkategorie  
 40           gemeldet wird.

- 4.** Mehrklassen-ATM-Verbindungszulassungsverfahren nach Anspruch 1, das die folgenden Schritte umfasst:

45           Feststellen, dass die empfangene Verbindungsanforderung zulässig ist, wenn das Zellenverlustverhältnis der durch die empfangene Verbindungsanforderung angeforderten Dienstkategorie kleiner oder gleich einem bestimmten Zellenverlustverhältnis ist, das bezüglich der Dienstkategorie gemeldet wird, und wenn das Zellenverlustverhältnis, das für jede der Dienstkategorien mit niedrigeren Prioritätsniveaus geschätzt wird, kleiner oder gleich einem bestimmten Zellenverlustverhältnis ist, das entsprechend für jede Dienstkategorie gemeldet wird;  
 50           Gewähren, dass Zellen des Anrufs in einem geeigneten Puffer gespeichert werden, wenn die Verbindungsanforderung für den Anruf als zulässig bestimmt worden ist, wobei für jede Dienstkategorie ein Puffer vorgesehen wird und die Prioritätsniveaus für jeden Puffer zugewiesen werden; und  
 Übertragen der in jedem Puffer gespeicherten Zellen über einen Übertragungsweg nur dann, wenn in irgendwelchen Puffern mit höheren Prioritätspegeln keine Zellen vorhanden sind.

- 55    **5.** Mehrklassen-ATM-Verbindungszulassungsvorrichtung, die umfasst:

            eine Empfangseinrichtung zum Empfangen einer Verbindungsanforderung für einen Anruf, der zu einer von

mehreren Dienstkategorien mit zugewiesenen Prioritätspegeln gehört;  
eine Klassifizierungseinrichtung zum Klassifizieren der empfangenen Verbindungsanforderung auf der Grundlage einer durch die Verbindungsanforderung angeforderten Dienstkategorie;  
eine Bewertungseinrichtung zum Bewerten einer Dienstqualität der durch die Verbindungsanforderung angeforderten Dienstkategorie und zum Bewerten einer Dienstqualität für jede andere Dienstkategorie unter der Annahme, dass die empfangene Verbindungsanforderung zugelassen worden ist, wobei die Bewertungseinrichtung ferner umfasst:

eine Schätzeinrichtung zum Schätzen eines Zellenverlustverhältnisses für den Verkehr, in dem Anrufe der Dienstkategorie, für die die Verbindungsanforderung empfangen worden ist, und Anrufe von Dienstkategorien mit niedrigeren Prioritätspegeln multiplexiert sind, und  
eine Schätzeinrichtung zum Schätzen eines Zellenverlustverhältnisses der Dienstkategorien mit niedrigeren Prioritätspegeln, wenn angenommen wird, dass alle auf der Grundlage des Zellenverlustverhältnisses des Verkehrs als verloren geltenden Zellen zu den Dienstkategorien mit niedrigeren Prioritätspegeln gehören;

eine Feststelleinrichtung zum Feststellen auf der Grundlage von Ergebnissen der Bewertungen, ob die empfangene Verbindungsanforderung zugelassen werden soll oder nicht; und  
eine Gewährseinrichtung zum Gewähren des Speicherns von Zellen eines Anrufs in einem Puffer, wenn für die Verbindungsanforderung für den Anruf festgestellt worden ist, dass sie zulässig ist.

6. Mehrklassen-ATM-Verbindungszulassungsvorrichtung nach Anspruch 5, bei der in der Gewährseinrichtung zum Gewähren des Speicherns von Zellen des Anrufs in einem geeigneten Puffer dann, wenn für die Verbindungsanforderung für den Anruf festgestellt worden ist, dass sie zulässig ist, ein Puffer für jede Dienstkategorie vorgesehen wird und die Prioritätsniveaus für jeden Puffer zugewiesen werden; und die ferner umfasst:

eine Übertragungseinrichtung zum Übertragen der in jedem Puffer gespeicherten Zellen über einen Übertragungsweg nur dann, wenn in irgendwelchen Puffern mit höheren Prioritätsniveaus keine Zellen vorhanden sind.

7. Mehrklassen-ATM-Verbindungszulassungsvorrichtung nach Anspruch 5, die umfasst:

eine Feststelleinrichtung zum Feststellen, dass die empfangene Verbindungsanforderung zulässig ist, wenn das Zellenverlustverhältnis der durch die empfangene Verbindungsanforderung angeforderten Dienstkategorie kleiner oder gleich einem bestimmten Zellenverlustverhältnis ist, das bezüglich der Dienstkategorie gemeldet wird, und wenn das Zellenverlustverhältnis, das für jede der Dienstkategorien mit niedrigeren Prioritätspegeln geschätzt wird, kleiner oder gleich einem bestimmten Zellenverlustverhältnis ist, das entsprechend für jede Dienstkategorie gemeldet wird.

8. Mehrklassen-ATM-Verbindungszulassungsvorrichtung nach Anspruch 5, die umfasst:

eine Feststelleinrichtung zum Feststellen, dass die empfangene Verbindungsanforderung zulässig ist, wenn das Zellenverlustverhältnis der durch die empfangene Verbindungsanforderung empfangenen Dienstkategorie kleiner oder gleich einem bestimmten Zellenverlustverhältnis ist, das bezüglich der Dienstkategorie gemeldet wird, und wenn das Zellenverlustverhältnis, das für jede der Dienstkategorien mit niedrigeren Prioritätspegeln geschätzt wird, kleiner oder gleich einem bestimmten Zellenverlustverhältnis ist, das entsprechend für jede Dienstkategorie gemeldet wird;  
eine Gewährseinrichtung zum Gewähren, dass Zellen des Anrufs in einem geeigneten Puffer gespeichert werden, wenn die Verbindungsanforderung für den Anruf als zulässig bestimmt worden ist, wobei für jede Dienstkategorie ein Puffer vorgesehen ist und die Prioritätspegel für jeden Puffer zugewiesen sind; und  
eine Übertragungseinrichtung zum Übertragen der in jedem Puffer gespeicherten Zellen über einen Übertragungsweg nur dann, wenn in irgendwelchen Puffern mit höheren Prioritätsniveaus keine Zellen vorhanden sind.

## Revendications

1. Procédé d'admission de connexion ATM à plusieurs classes comprenant les étapes consistant à :

recevoir une requête de connexion pour un appel appartenant à l'une d'une pluralité de catégories de services avec des niveaux de priorité affectés ;  
classifier la requête de connexion reçue en se basant sur une catégorie de services demandée par la requête de connexion ;

5 évaluer une qualité de service de ladite catégorie de services demandée par la requête de connexion et évaluer une qualité de service de l'une, l'autre catégorie de services, si on suppose que la requête de connexion reçue a été admise, l'étape d'évaluation comprenant en outre l'étape consistant à :

10 estimer un taux de perte de cellules pour le trafic dans lequel des appels de la catégorie de services pour laquelle la requête de connexion a été reçue et des appels de catégories de services de niveaux de priorité inférieurs sont multiplexés, et

estimer un taux de perte de cellules desdites catégories de services de niveaux de priorité inférieurs si on suppose que toutes les cellules perdues sur la base du taux de perte de cellules dudit trafic appartiennent auxdites catégories de services de niveaux de priorité inférieurs ;

15 déterminer si oui ou non il faut admettre la requête de connexion reçue en se basant sur les résultats desdites évaluations ; et

permettre aux cellules dudit appel d'être stockées dans une mémoire tampon lorsque la requête de connexion pour ledit appel a été déterminée admissible.

- 20
2. Procédé d'admission de connexion ATM à plusieurs classes selon la revendication 1, dans lequel, à l'étape consistant à permettre aux cellules dudit appel d'être stockées dans une mémoire tampon appropriée lorsque la requête de connexion pour ledit appel a été déterminée admissible, une mémoire tampon est prévue pour chaque catégorie de services et lesdits niveaux de priorité sont affectés pour chaque mémoire tampon ; et qui comprend
- 25 en outre l'étape consistant à :

transférer les cellules stockées dans chaque mémoire tampon sur une voie de transmission uniquement lorsqu'il n'y a aucune cellule présente dans des mémoires tampons quelconques ayant des niveaux de priorité supérieurs.

- 30
3. Procédé d'admission de connexion ATM à plusieurs classes selon la revendication 1, qui comprend en outre l'étape consistant à :

35 déterminer la requête de connexion reçue admissible lorsque le taux de perte de cellules de la catégorie de services demandée par la requête de connexion reçue est inférieur ou égal à un taux de perte de cellules spécifié rapporté sur la catégorie de services, et le taux de perte de cellules estimé pour chacune desdites catégories de services est inférieur ou égale à un taux de perte de cellule spécifié respectivement rapporté sur chaque catégorie de service.

- 40
4. Procédé d'admission de connexion ATM à plusieurs classes selon la revendication 1, qui comprend les étapes consistant à :

45 déterminer la requête de connexion reçue admissible lorsque le taux de perte de cellules de la catégorie de services demandée par la requête de connexion reçue est inférieur ou égal à un taux de perte de cellules rapporté sur la catégorie de services, et le taux de perte de cellules estimé pour chacune desdites catégories de services de niveaux de priorité inférieurs est inférieur ou égal à un taux de perte de cellules spécifié respectivement rapporté sur chaque catégorie de services ;

permettre aux cellules dudit appel d'être stockées dans une mémoire tampon appropriée lorsque la requête de connexion pour ledit appel a été déterminée admissible, dans lequel une mémoire tampon est prévue pour

50 chaque catégorie de services et lesdits niveaux de priorité sont affectés pour chaque mémoire tampon ; et transférer les cellules stockées dans chaque mémoire tampon sur une voie de transmission uniquement lorsqu'il n'y a aucune cellule présente dans des mémoires tampon quelconques ayant des niveaux de priorité supérieurs.

- 55
5. Dispositif d'admission de connexion ATM à plusieurs classes comprenant :

des moyens de réception destinés à recevoir une requête de connexion pour un appel appartenant à l'une d'une pluralité de catégories de services avec des niveaux de priorité affectés ;

des moyens de classification destinés à classifier la requête de connexion reçue en se basant sur une catégorie de services demandée par la requête de connexion ;

des moyens d'évaluation destinés à évaluer une qualité de service de ladite catégorie de services demandée par la requête de connexion et évaluer une qualité de service de l'une, l'autre catégorie de services, si on suppose que la requête de connexion demandée a été admise, les moyens d'évaluation comprenant en outre :

des moyens d'estimation destinés à estimer un taux de perte de cellules pour le trafic dans lequel des appels de la catégorie de service pour laquelle la requête de connexion a été reçue et des appels de catégories de services de niveaux de priorité inférieurs sont multiplexés, et

des moyens d'estimation destinés à estimer un taux de perte de cellules desdites catégories de services de niveaux de priorité inférieurs si on suppose que la totalité des cellules perdues en se basant sur le taux de perte de cellules dudit trafic appartient auxdites catégories de services de niveaux de priorité inférieurs ;

des moyens de détermination destinés à déterminer si oui ou non il faut admettre la requête de connexion reçue en se basant sur les résultats desdites évaluations ; et

des moyens de permission destinés à permettre aux cellules desdits appels d'être stockées dans une mémoire tampon lorsque la requête de connexion pour ledit appel a été déterminée admissible.

6. Dispositif d'admission de connexion ATM à plusieurs classes selon la revendication 5, dans lequel, dans les moyens de permission destinés à permettre aux cellules dudit appel d'être stockées dans une mémoire tampon appropriée lorsque la requête de connexion pour ledit appel a été déterminée admissible, une mémoire tampon est prévue pour chaque catégorie de services et lesdits niveaux de priorité sont affectés pour chaque mémoire tampon ; et qui comprend en outre :

des moyens de transfert destinés à transférer les cellules stockées dans chaque mémoire tampon sur une voie de transmission uniquement lorsqu'il n'y a aucune cellule présente dans des mémoires tampon quelconques ayant des niveaux de priorité supérieurs.

7. Dispositif d'admission de connexion ATM à plusieurs classes selon la revendication 5, qui comprend :

des moyens de détermination destinés à déterminer que la requête de connexion est admissible lorsque le taux de perte de cellules de la catégorie de services demandée par la requête de connexion reçue est inférieur ou égal à un taux de perte de cellules spécifié rapporté sur la catégorie de services, et le taux de perte de cellules estimé pour chacune desdites catégories de services de niveaux de priorité inférieurs est inférieur ou égal à un taux de perte de cellules spécifié respectivement rapporté sur chaque catégorie de services.

8. Dispositif d'admission de connexion ATM à plusieurs classes selon la revendication 5, qui comprend :

des moyens de détermination destinés à déterminer que la requête de connexion reçue est admissible lorsque le taux de perte de cellules de la catégorie de services demandée par la requête de connexion reçue est inférieur ou égal à un taux de perte de cellules spécifié rapporté sur la catégorie de services, et le taux de perte de cellules estimé pour chacune desdites catégories de services de niveaux de priorité inférieurs est inférieur ou égal à un taux de perte de cellules spécifié respectivement rapporté sur chaque catégorie de services ;

des moyens de permission destinés à permettre aux cellules dudit appel d'être stockées dans une mémoire tampon appropriée lorsque la requête de connexion pour ledit appel a été déterminée admissible, dans lequel une mémoire tampon est prévue pour chaque catégorie de services et lesdits niveaux de priorité sont affectés pour chaque mémoire tampon ; et

des moyens de transfert destinés à transférer les cellules stockées dans chaque mémoire tampon sur une voie de transmission uniquement lorsqu'il n'y a qu'aucune cellule présente dans des mémoires tampon quelconques ayant des niveaux de priorité supérieurs.

FIG. 1

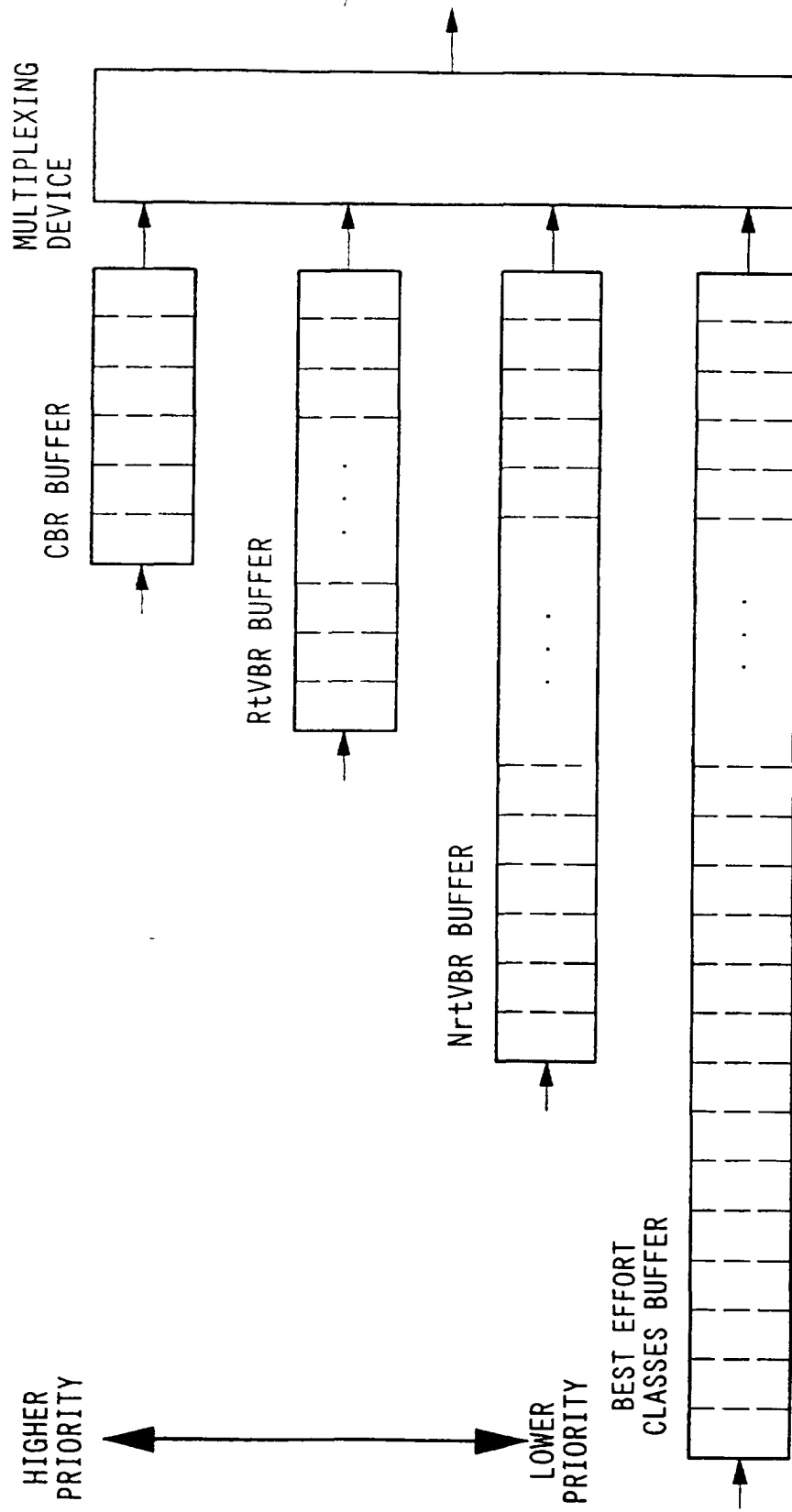


FIG. 2

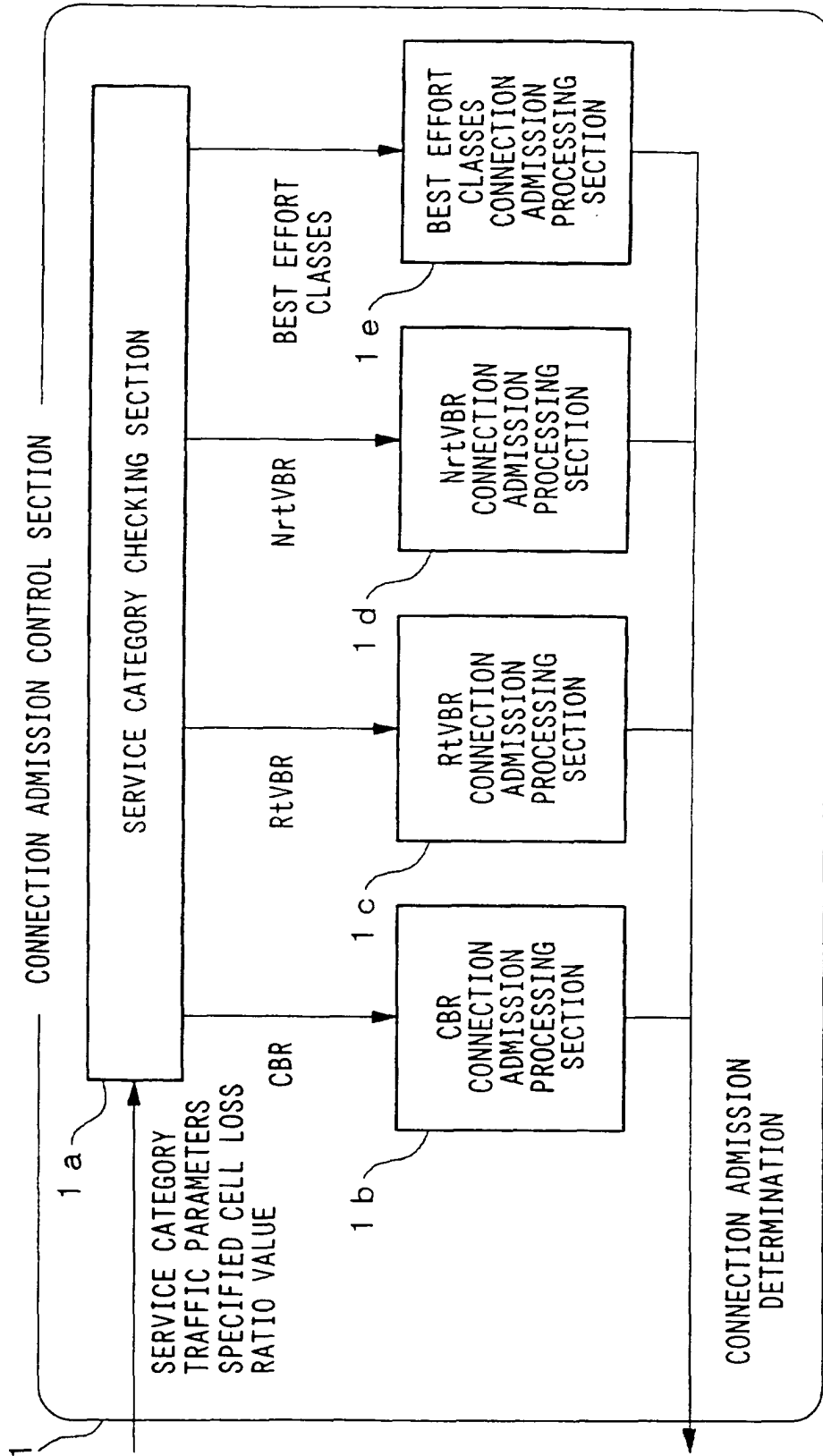


FIG. 3

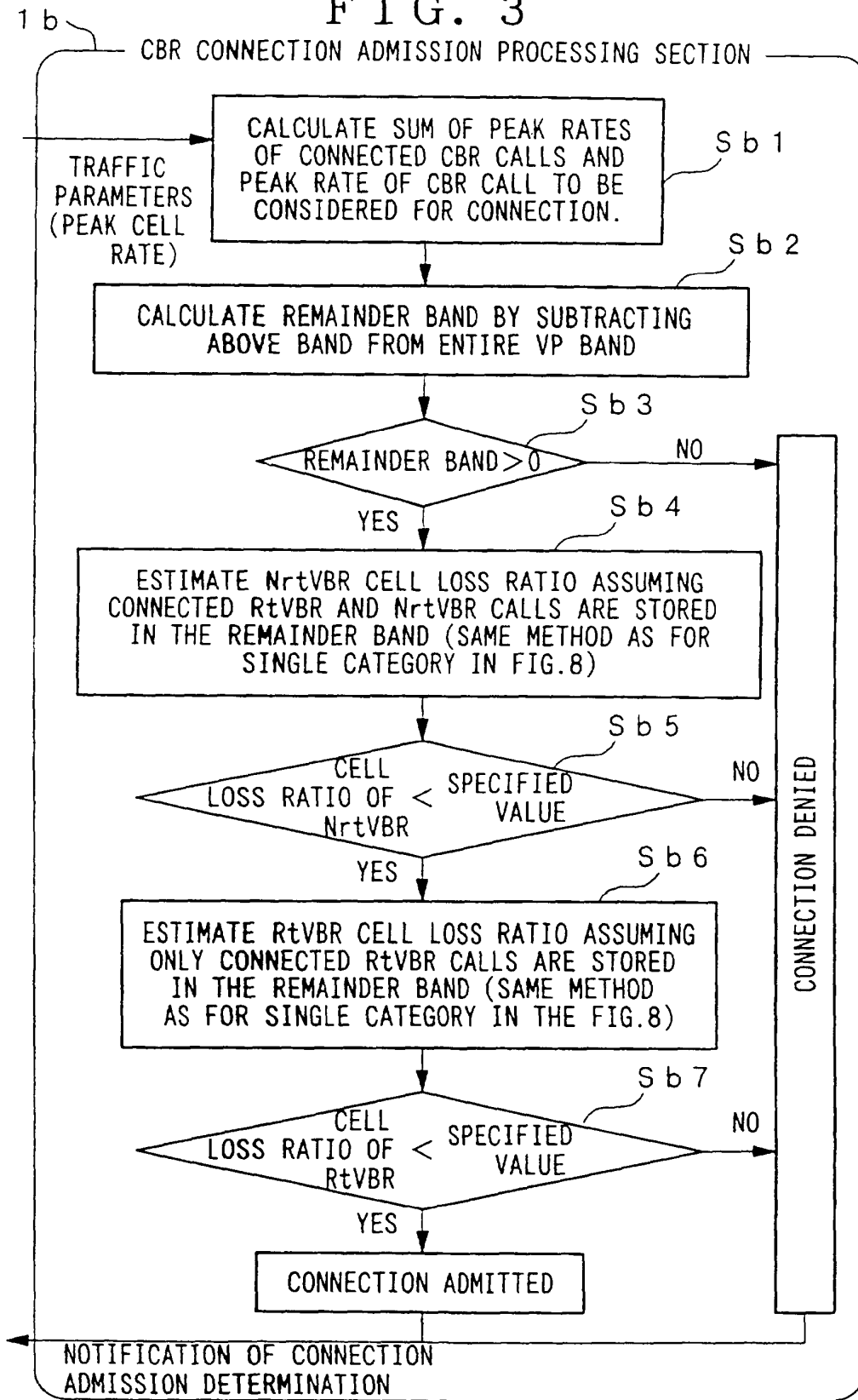
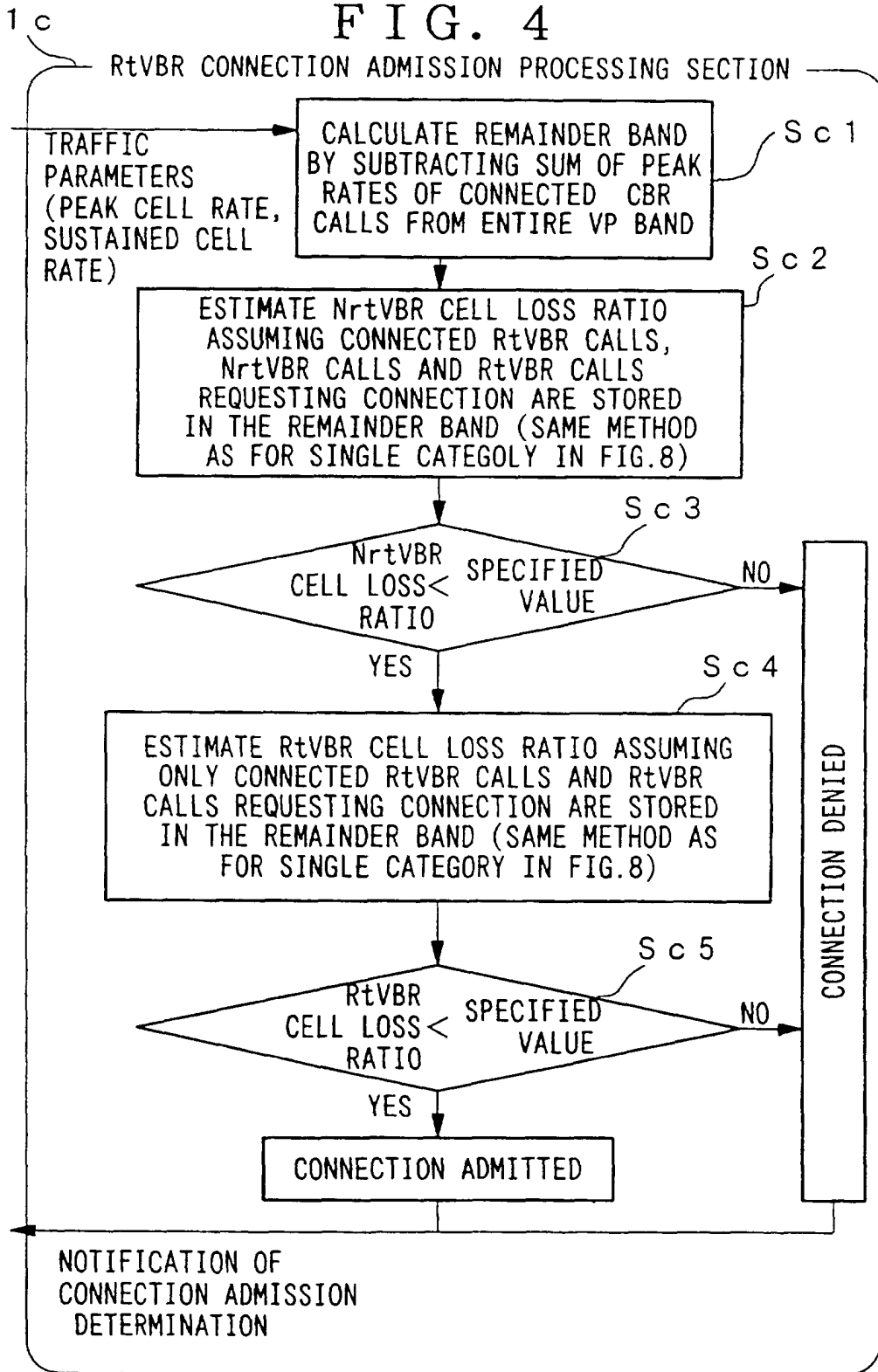


FIG. 4



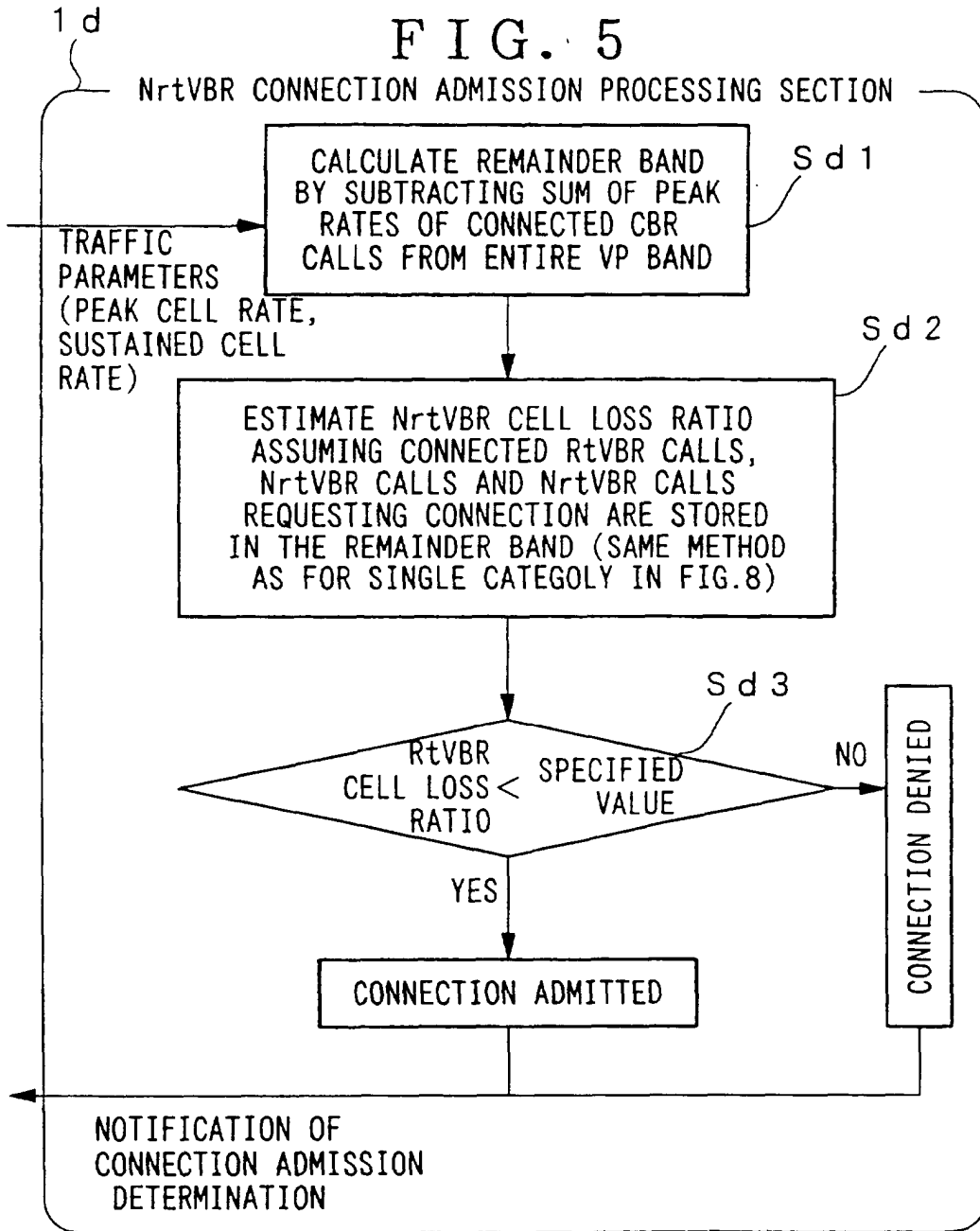


FIG. 6

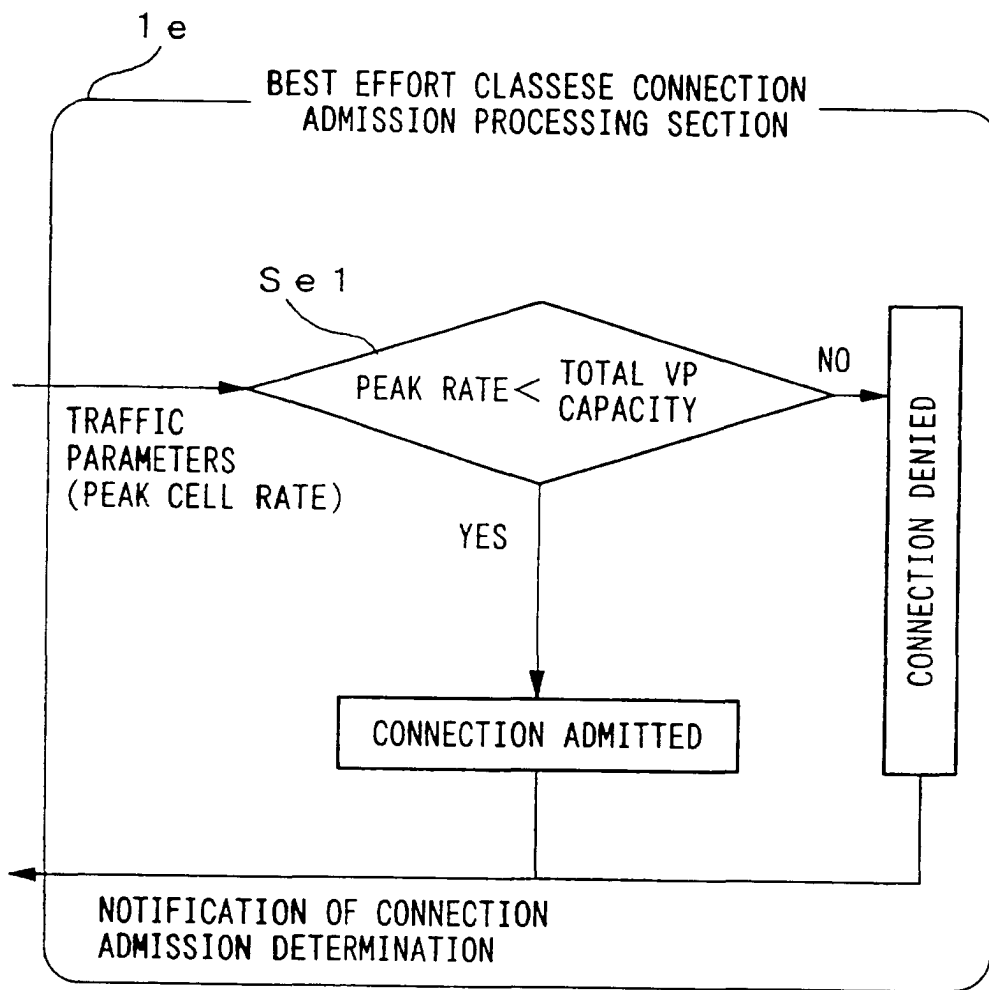


FIG. 7

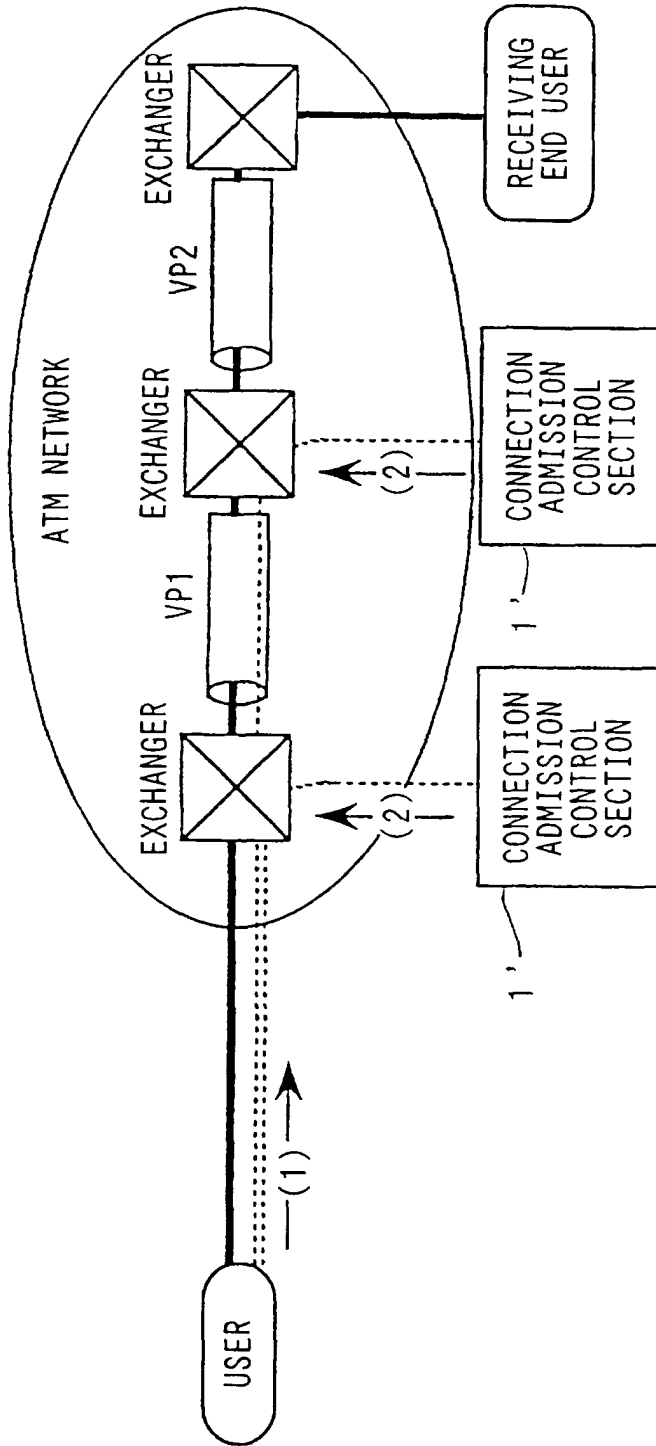


FIG. 8

